

WE CLAIM:

- 1 1. A process for regenerating non-combustible sorbents comprising one
2 or more combustible impurities comprising phosphorus, said process comprising:
3 providing one or more spent non-combustible sorbents comprising a content of
4 said one or more combustible impurities comprising phosphorus;
5 exposing said one or more non-combustible sorbents to regeneration
6 conditions effective to remove said combustible impurities comprising
7 phosphorus and to produce a regenerated sorbent effective to sorb 80
8 wt.% or more of said content of one or more combustible impurities
9 comprising phosphorus.
- 1 2. The process of claim 1 wherein said combustible impurities comprising
2 phosphorus comprise basic combustible impurities comprising phosphorus.
- 1 3. The process of claim 2 wherein said regenerated sorbent is effective to
2 sorb 90 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.
- 1 4. The process of claim 2 wherein said regenerated sorbent is effective to
2 sorb 95 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.
- 1 5. The process of claim 2 wherein said regenerated sorbent is effective to
2 sorb substantially all of said content of one or more combustible impurities
3 comprising phosphorus.
- 1 6. The process of claim 5 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 200°C to about
3 700°C.

1 7. The process of claim 5 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 450°C to about
3 600°C.

1 8. The process of claim 6 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 9. The process of claim 7 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 10. The process of claim 8 wherein said oxygen containing atmosphere is
2 selected from the group consisting of air, oxygen gas, and a combination of oxygen
3 gas with nitrogen gas.

1 11. The method of claim 8 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

1 12. The method of claim 8 wherein said quantity of oxygen is from about
2 0.5 to about 21% of said oxygen containing atmosphere.

1 13. The method of claim 9 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

1 14. The method of claim 9 wherein said quantity of oxygen is from about
2 0.5 to about 21% of said oxygen containing atmosphere.

1 15. The process of claim 9 wherein said oxygen containing atmosphere
2 comprises nitrogen and about 0.5 to about 1% oxygen.

1 16. The process of claim 15 further comprising a pressure from about 0.01
2 MPa to about 50 MPa.

1 17. The process of claim 15 further comprising a pressure from about 0.1
2 MPa to about 10 MPa.

1 18. The process of claim 16 wherein

2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from about 0.5 hour to about 200 hours; and,
5 said spent sorbent is cooled to at least about 100 °C.

1 19. The process of claim 17 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from about 0.5 hour to about 200 hours; and,
5 said spent sorbent is cooled to at least about 100 °C.

1 20. The process of claim 17 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from
5 about 0.5 hour to about 200 hours; and,
6 said spent sorbent is cooled to at least about 25 °C or less.

1 21. The method of claim 5 further comprising:
2 providing an olefin feed comprising a content of phosphorus-containing
3 impurities;
4 contacting said olefin feed with said one or more sorbents under sorbing
5 conditions and for a time effective to produce a purified olefin feed and
6 said one or more spent sorbents.

1 22. The method of claim 21 further comprising contacting said purified
2 olefin feed with a skeletal isomerization catalyst under conditions effective to yield
3 skeletally isomerized olefins.

1 23. The method of claim 22 further comprising converting said skeletally
2 isomerized olefins into a primary alcohol composition.

1 24. The process of claim 23 wherein said converting comprises
2 hydroformylating said skeletally isomerized olefin.

1 25. The process of claim 21 wherein said purified olefin feed consists of
2 about 1 ppm or less of said phosphorus-containing impurities.

1 26. The process of claim 21 wherein said purified olefin feed consists of
2 about 0.5 ppm or less of said phosphorus-containing impurities.

1 27. A process for regenerating non-combustible sorbents comprising one
2 or more impurities comprising phosphorus, said process comprising:
3 providing one or more spent non-combustible sorbents comprising a content of
4 said one or more combustible impurities comprising phosphorus, said
5 one or more sorbents comprising a non-combustible support
6 comprising a metal selected from the group consisting of Sc, V, Cr, Fe,
7 Co, Ni, Cu, Zn, Zr, Nb, Mn, Ag and combinations thereof; and
8 exposing said one or more non-combustible sorbents to regeneration
9 conditions effective to remove combustible impurities comprising
10 phosphorus and to produce a regenerated sorbent effective to sorb 80
11 wt.% or more of said content of one or more combustible impurities
12 comprising phosphorus.

1 28. The process of claim 27 wherein said combustible impurities
2 comprising phosphorus comprise basic combustible impurities comprising
3 phosphorus.

1 29. The process of claim 28 wherein said regenerated sorbent is effective
2 to sorb 90 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.

1 30. The process of claim 28 wherein said regenerated sorbent is effective
2 to sorb 95 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.

1 31. The process of claim 28 wherein said regenerated sorbent is effective
2 to sorb substantially all of said content of one or more combustible impurities
3 comprising phosphorus.

1 32. The process of claim 31 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 200°C to about
3 700°C.

1 33. The process of claim 31 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 450°C to about
3 600°C.

1 34. The process of claim 32 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 35. The process of claim 33 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 36. The process of claim 34 wherein said oxygen containing atmosphere is
2 selected from the group consisting of air, oxygen gas, and a combination of oxygen
3 gas with nitrogen gas.

1 37. The method of claim 34 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

1 38. The method of claim 34 wherein said quantity of oxygen is from about
2 0.5 to about 21% of said oxygen containing atmosphere.

1 39. The method of claim 35 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

1 40. The method of claim 35 wherein said quantity of oxygen is from about
2 0.5 to about 21% of said oxygen containing atmosphere.

1 41. The process of claim 35 wherein said oxygen containing atmosphere
2 comprises nitrogen and from about 0.5% to about 1% oxygen.

1 42. The process of claim 38 further comprising a pressure from about 0.01
2 MPa to about 50 MPa.

1 43. The process of claim 41 further comprising a pressure from about 0.1
2 MPa to about 10 MPa.

1 44. The process of claim 42 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from about 0.5 hour to about 200 hours; and,
5 said spent sorbent is cooled to at least about 100 °C.

1 45. The process of claim 43 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from about 0.5 hour to about 200 hours; and,
5 said spent sorbent is cooled to at least about 100 °C.

1 46. The process of claim 42 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;

4 said temperature is maintained from
5 about 0.5 hour to about 200 hours; and,
6 said spent sorbent is cooled to at least about 25 °C or less.

1 47. The method of claim 28 wherein said non-combustible support is
2 selected from the group consisting of acidic zeolite, acidic alumina, and neutral
3 alumina.

1 48. The method of claim 46 wherein said non-combustible support is
2 selected from the group consisting of acidic zeolite, acidic alumina, and neutral
3 alumina.

1 49. The method of claim 31 further comprising:
2 providing an olefin feed comprising a content of said combustible impurities
3 comprising phosphorus;
4 contacting said olefin feed with said one or more sorbents under sorbing
5 conditions and for a time effective to produce a purified olefin feed and
6 said one or more spent sorbents.

1 50. The method of claim 42 further comprising contacting said purified
2 olefin feed with a skeletal isomerization catalyst under conditions effective to yield
3 skeletal isomerized olefins.

1 51. The method of claim 49 further comprising converting said skeletal
2 isomerized olefins into a primary alcohol composition.

1 52. The process of claim 50 wherein said converting comprises
2 hydroformylating said skeletal isomerized olefin.

1 53. The process of claim 51 wherein said purified olefin feed consists of
2 about 1 ppm or less of said phosphorus-containing impurities.

1 54. The process of claim 51 wherein said purified olefin feed consists of
2 about 0.5 ppm or less of said phosphorus-containing impurities.

1 55. A process for regenerating non-combustible sorbents comprising one
2 or more impurities comprising phosphorus, said process comprising:

3 providing one or more spent non-combustible sorbents comprising a content of
4 said one or more combustible impurities comprising phosphorus,
5 comprising a metal selected from the group consisting of Cu, Ag and
6 combinations thereof, and comprising a support selected from the
7 group consisting of acidic zeolite, acidic alumina, and neutral alumina;
8 and
9 exposing said one or more non-combustible sorbents to regeneration
10 conditions effective to produce a regenerated sorbent effective to sorb a
11 majority of said content of said one or more combustible impurities
12 comprising phosphorus or more.

1 56. The process of claim 55 wherein said combustible impurities
2 comprising phosphorus comprise basic combustible impurities comprising
3 phosphorus.

1 57. The process of claim 56 wherein said regenerated sorbent is effective
2 to sorb 90 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.

1 58. The process of claim 56 wherein said regenerated sorbent is effective
2 to sorb 95 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.

1 59. The process of claim 56 wherein said regenerated sorbent is effective
2 to sorb substantially all of said content of one or more combustible impurities
3 comprising phosphorus.

1 60. The process of claim 59 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 200°C to about
3 700°C.

1 61. The process of claim 59 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 450°C to about
3 600°C.

1 62. The process of claim 60 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 63. The process of claim 61 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 64. The process of claim 62 wherein said oxygen containing atmosphere is
2 selected from the group consisting of air, oxygen gas, and a combination of oxygen
3 gas with nitrogen gas.

1 65. The method of claim 62 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

1 66. The method of claim 62 wherein said quantity of oxygen is from about
2 0.5 to about 21% of said oxygen containing atmosphere.

1 67. The method of claim 63 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

1 68. The method of claim 63 wherein said quantity of oxygen is from about
2 0.5 to about 21% of said oxygen containing atmosphere.

1 69. The process of claim 63 wherein said oxygen containing atmosphere
2 comprises nitrogen and from about 0.5% to about 1% oxygen.

1 70. The process of claim 68 further comprising a pressure from about 0.01
2 MPa to about 50 MPa.

1 71. The process of claim 69 further comprising a pressure from about 0.1
2 MPa to about 10 MPa.

1 72. The process of claim 70 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from about 0.5 hour to about 200 hours; and,
5 said spent sorbent is cooled to at least about 100 °C.

1 73. The process of claim 71 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from about 0.5 hour to about 200 hours; and,
5 said spent sorbent is cooled to at least about 100 °C.

1 74. The process of claim 70 wherein
2 said oxygen containing atmosphere is supplied at a flow rate of from about
3 0.001 to about 50 liters/hour per gram catalyst;
4 said temperature is maintained from
5 about 0.5 hour to about 200 hours; and,
6 said spent sorbent is cooled to at least about 25 °C or less.

1 75. The method of claim 69 further comprising:
2 providing an olefin feed comprising a content of said combustible impurities
3 comprising phosphorus;

4 contacting said olefin feed with said one or more sorbents under sorbing
5 conditions and for a time effective to produce a purified olefin feed and
6 said one or more spent sorbents.

1 76. The method of claim 75 further comprising contacting said purified
2 olefin feed with a skeletal isomerization catalyst under conditions effective to yield
3 skeletal isomerized olefins.

1 77. The method of claim 76 further comprising converting said skeletal
2 isomerized olefins into a primary alcohol composition.

1 78. The process of claim 77 wherein said converting comprises
2 hydroformylating said skeletal isomerized olefin.

1 79. The process of claim 78 wherein said purified olefin feed consists of
2 about 1 ppm or less of said phosphorus-containing impurities.

1 80. The process of claim 78 wherein said purified olefin feed consists of
2 about 0.5 ppm or less of said phosphorus-containing impurities.

1 81. A process for regenerating non-combustible sorbents comprising one
2 or more combustible impurities comprising phosphorus, said process comprising:

3 providing one or more spent, non-combustible sorbents comprising one or
4 more combustible impurities comprising phosphorus, said spent, non-
5 combustible sorbents comprising a metal selected from the group
6 consisting of Cu, Ag and combinations thereof, and comprising a
7 support comprising acidic alumina; and,

8 exposing said spent sorbents to regeneration conditions consisting essentially
9 of a quantity of a gas comprising from about 0.5 to about 21% oxygen
10 with the remainder being nitrogen a temperature of from about 450°C
11 to about 600°C and a pressure of from about 0.1 MPa to about 10 MPa,

12 at a flow rate and for a time effective to produce a regenerated sorbent
13 effective to sorb a majority of said content of combustible impurities
14 comprising phosphorus or more.

1 82. The process of claim 81 wherein said combustible impurities
2 comprising phosphorus comprise basic combustible impurities comprising
3 phosphorus.

1 83. The process of claim 82 wherein said regenerated sorbent is effective
2 to sorb 90 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.

1 84. The process of claim 82 wherein said regenerated sorbent is effective
2 to sorb 95 wt.% or more of said content of one or more combustible impurities
3 comprising phosphorus.

1 85. The process of claim 82 wherein said regenerated sorbent is effective
2 to sorb substantially all of said content of one or more combustible impurities
3 comprising phosphorus.

1 86. The process of claim 82 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 200°C to about
3 700°C.

1 87. The process of claim 82 wherein said regeneration conditions consist
2 essentially of a quantity of oxygen and a temperature from about 450°C to about
3 600°C.

1 88. The process of claim 86 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 89. The process of claim 87 wherein said quantity of oxygen comprises an
2 oxygen containing atmosphere.

1 90. The process of claim 88 wherein said oxygen containing atmosphere is
2 selected from the group consisting of air, oxygen gas, and a combination of oxygen
3 gas with nitrogen gas.

1 91. The method of claim 88 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

1 92. The method of claim 88 wherein said quantity of oxygen is from about
2 0.5 to about 21% of said oxygen containing atmosphere.

1 93. The method of claim 89 wherein said quantity of oxygen is about
2 0.001% or more of said oxygen containing atmosphere.

3 94. The method of claim 89 wherein said quantity of oxygen is from about
4 0.5 to about 21% of said oxygen containing atmosphere.

1 95. The process of claim 89 wherein said oxygen containing atmosphere
2 comprises nitrogen and from about 0.5% to about 1% oxygen.

1 96. The process of claim 92 further comprising a pressure from about 0.01
2 MPa to about 50 MPa.

1 97. The process of claim 95 further comprising a pressure from about 0.1
2 MPa to about 10 MPa.

1 98. The process of claim 96 wherein
2 said flow rate is from 0.001 to about 50 liters/hour per gram catalyst;
3 said temperature is maintained from about 0.5 hour to about 200 hours; and,
4 said spent sorbent is cooled to at least about 100 °C.

1 99. The process of claim 97 wherein
2 said flow rate is from 0.001 to about 50 liters/hour per gram catalyst;

3 said temperature is maintained from about 0.5 hour to about 200 hours; and,
4 said spent sorbent is cooled to at least about 100 °C.

1 100. The process of claim 97 wherein
2 said flow rate is from 0.001 to about 50 liters/hour per gram catalyst;
3 said temperature is maintained from
4 about 0.5 hour to about 200 hours; and,
5 said spent sorbent is cooled to at least about 25 °C or less.

1 101. The method of claim 85 further comprising:
2 providing an olefin feed comprising a content of said combustible impurities
3 comprising phosphorus;
4 contacting said olefin feed with said one or more sorbents under sorbing
5 conditions and for a time effective to produce a purified olefin feed and
6 said one or more spent sorbents.

1 102. The method of claim 101 further comprising contacting said purified
2 olefin feed with a skeletal isomerization catalyst under conditions effective to yield
3 skeletal isomerized olefins.

1 103. The method of claim 102 further comprising converting said skeletally
2 isomerized olefins into a primary alcohol composition.

1 104. The process of claim 103 wherein said converting comprises
2 hydroformylating said skeletally isomerized olefin.

1 105. The process of claim 104 wherein said purified olefin feed consists of
2 about 1 ppm or less of said phosphorus-containing impurities.

1 106. The process of claim 105 wherein said purified olefin feed consists of
2 about 0.5 ppm or less of said phosphorus-containing impurities.

1 107. A process for regenerating non-combustible sorbents comprising
2 combustible impurities comprising phosphorus, said process comprising:
3 providing one or more spent, non-combustible sorbents selected from the
4 group consisting of acidic zeolite, acidic alumina, and neutral alumina,
5 said one or more spent, non-combustible sorbents comprising at least
6 one combustible impurity comprising phosphorus; and
7 exposing said one or more spent, non-combustible sorbents to regeneration
8 conditions consisting essentially of a quantity of a gas comprising from
9 about 0.5 to about 21% oxygen with the remainder being nitrogen a
10 temperature from about 450°C to about 600°C, a pressure from about
11 0.1 MPa to about 10 MPa at a flow rate and for a time effective to
12 produce a regenerated sorbent effective to sorb at least 95 wt.% of said
13 content of combustible impurities comprising phosphorus or more.

1 108. The method of claim 107 further comprising:
2 providing an olefin feed comprising a content of said combustible impurities
3 comprising phosphorus;
4 contacting said olefin feed with said one or more sorbents under sorbing
5 conditions and for a time effective to produce a purified olefin feed and
6 said one or more spent sorbents.

1 109. The method of claim 108 further comprising contacting said purified
2 olefin feed with a skeletal isomerization catalyst under conditions effective to yield
3 skeletal isomerized olefins.

1 110. The method of claim 109 further comprising converting said skeletal
2 isomerized olefins into a primary alcohol composition.

1 111. The process of claim 110 wherein said converting comprises
2 hydroformylating said skeletally isomerized olefin.

1 112. The process of claim 111 wherein said purified olefin feed consists of
2 about 1 ppm or less of said phosphorus-containing impurities.

1 113. The process of claim 111 wherein said purified olefin feed consists of
2 about 0.5 ppm or less of said phosphorus-containing impurities.

1 114. A process for regenerating acidic alumina comprising at least one
2 combustible impurity comprising phosphorus, said process comprising:

3 providing a spent sorbent consisting essentially of acidic alumina comprising a
4 content of at least one combustible impurity comprising phosphorus;
5 and

6 exposing said spent sorbent to regeneration conditions consisting essentially of
7 a quantity of a gas comprising from about 0.5 to about 21% oxygen
8 with the remainder being nitrogen, a temperature from about 450°C to
9 about 600°C, a pressure from about 0.1 MPa to about 10 MPa, at a
10 flow rate and for a time effective to produce a regenerated sorbent
11 effective to sorb a majority of said content of said combustible
12 impurities comprising phosphorus or more.

1 115. The process of claim 114 wherein said combustible impurities
2 comprising phosphorus comprise basic combustible impurities comprising
3 phosphorus.

1 116. The method of claim 115 further comprising:
2 providing an olefin feed comprising a content of said combustible impurities
3 comprising phosphorus;

4 contacting said olefin feed with said one or more sorbents under sorbing
5 conditions and for a time effective to produce a purified olefin feed and
6 said one or more spent sorbents.

1 117. The method of claim 116 further comprising contacting said purified
2 olefin feed with a skeletal isomerization catalyst under conditions effective to yield
3 skeletal isomerized olefins.

1 118. The method of claim 117 further comprising converting said skeletal
2 isomerized olefins into a primary alcohol composition.

1 119. The process of claim 118 wherein said converting comprises
2 hydroformylating said skeletal isomerized olefin.

1 120. The process of claim 119 wherein said purified olefin feed consists of
2 about 1 ppm or less of said phosphorus-containing impurities.

1 121. The process of claim 120 wherein said purified olefin feed consists of
2 about 0.5 ppm or less of said phosphorus-containing impurities.

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